GPM for Landslide Prediction

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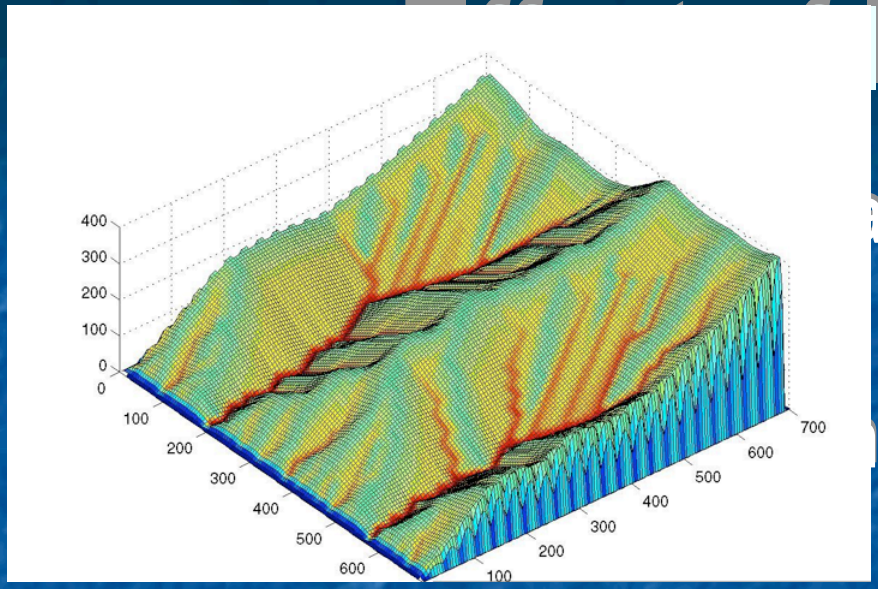
Introduction

- Landslides as weather phenomena
- Conceptual requirements for landslide prediction at relevant spatiotemporal scales
- Data available, data required
- A framework for landslide prediction
- Conclusions

landslides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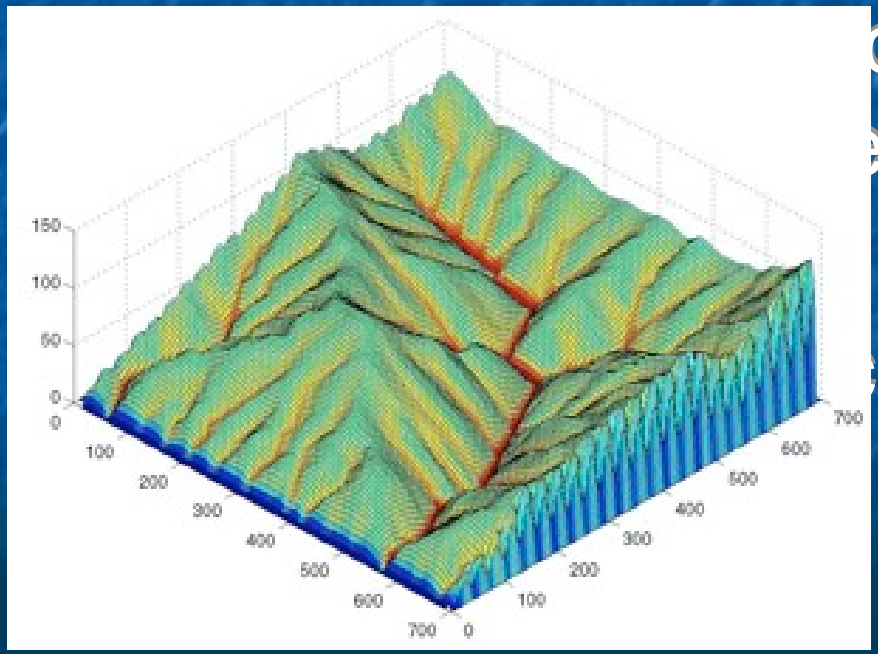
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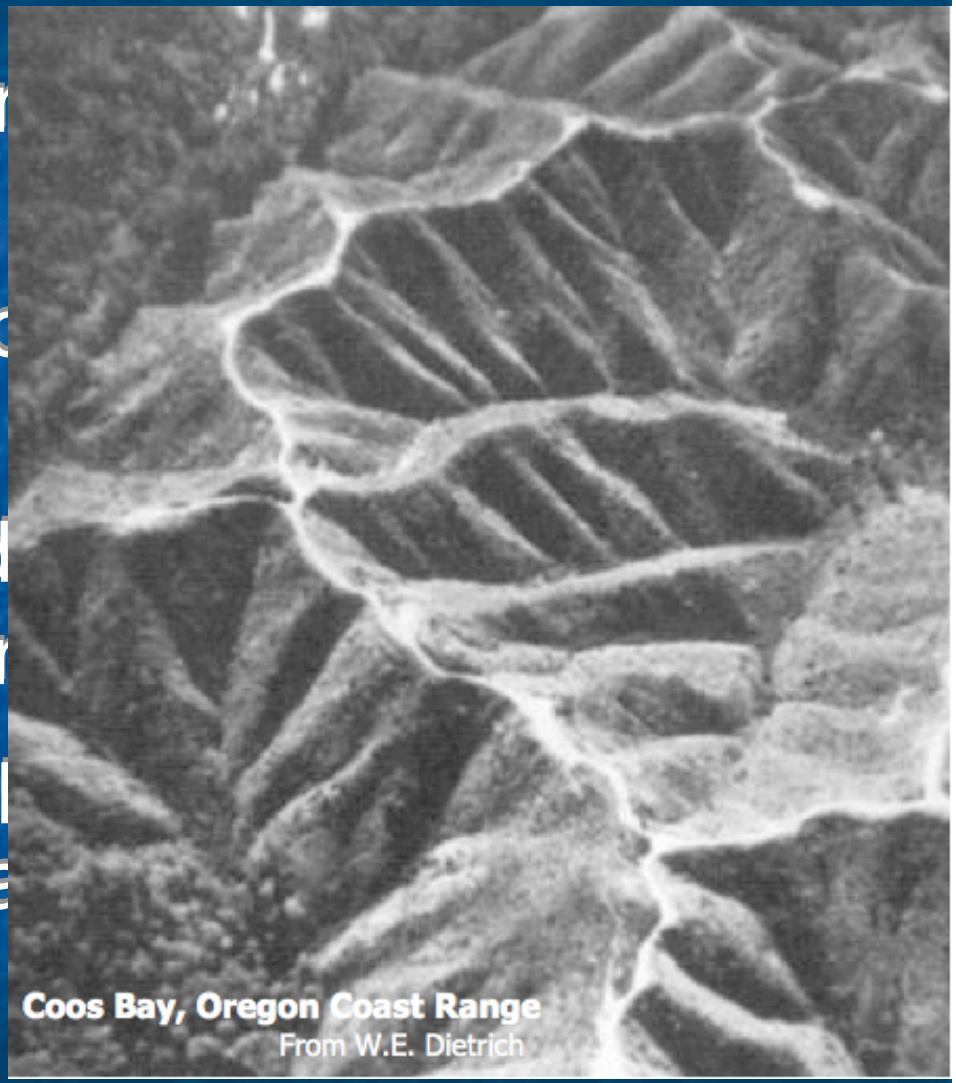
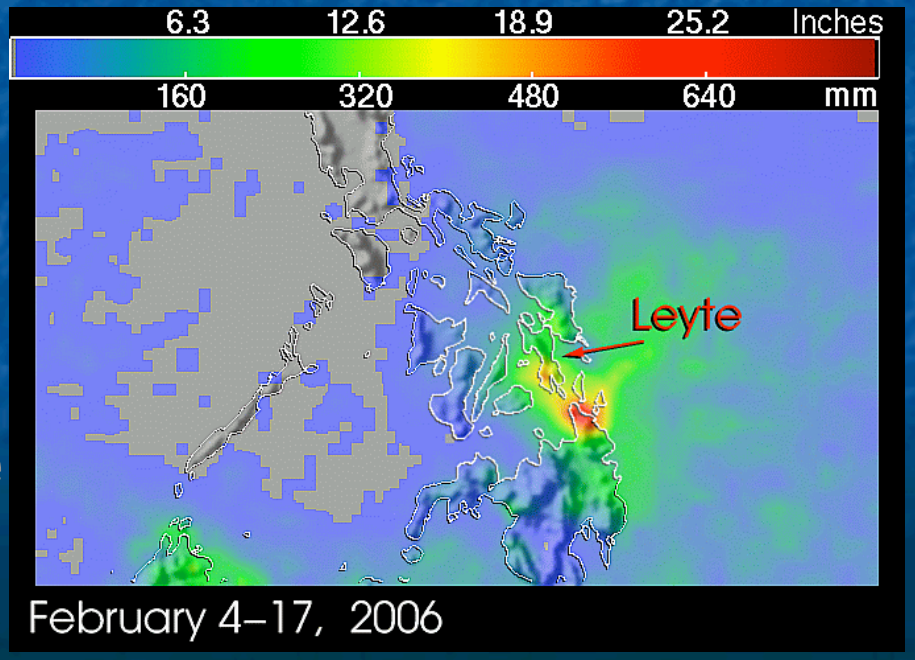

Coos Bay, Oregon Coast Range
From W.E. Dietrich

Landslides as weather phenomena

- Extreme rainfall among the most common triggers
- St. Bernard landslide: TRMM recorded 500 mm Feb. 4-7, 2006
- In the US landslides cause 25-50 fatalities and $1-2B in damage annually
- Ubiquitous in the steep lands of the world
- Devastating in areas with little/no hazard assessment, preventative building codes



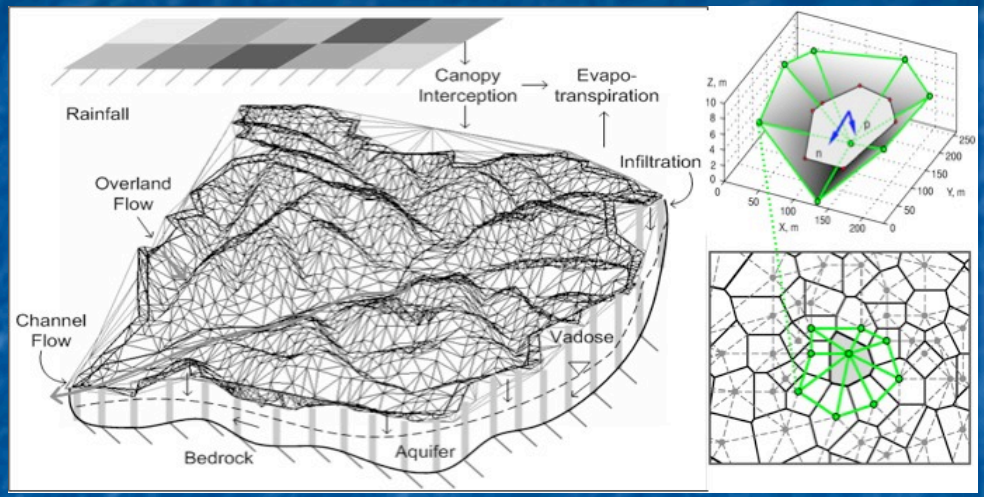
Venezuela 1999:

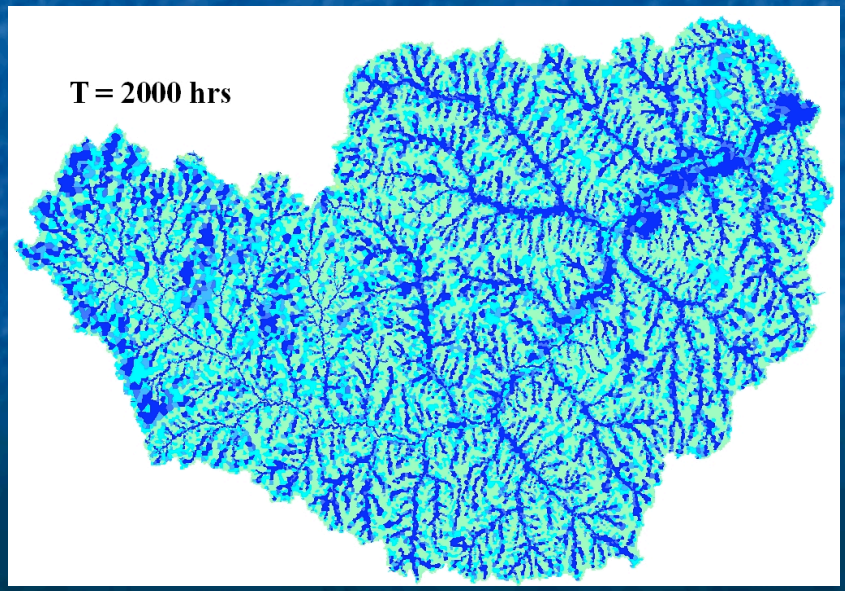
What is needed to predict landslides?

- Distributed watershed hydrology models that resolve spatial soil moisture patterns at high resolution
- Data to calibrate and parameterize models
- Observations of hydrological states to constrain to models
- Hydrometeorological forcings

Process Hydrology Models

- TIN-based Real-time Integrated Basin Simulator (tRIBS)
- Multi-resolution approach
- Soil moisture at scales 10 - 100 m
- Unsaturated lateral moisture redistribution
- Vegetation intercepts rain and alters local soil moisture





Data needs and availability

- Data to parameterize boundary conditions:
  - Topographic data ✓ SRTM
  - Vegetation data ✓ MODIS, LandSAT
  - Soils data ✓ Soil databases
- Observational data to constrain:
  - Soil moisture/canopy water content ✓ AMSR-E

Data needs and availability (cont.)

- Hydrometeorological forcings
  - Air temperature ✓ MODIS
  - Humidity ✓ MODIS
  - Radiation forcings ✓ MODIS, GOES
- Rainfall forcing
  - High resolution rainfall (kilometers) with high frequency revisit (hours to days)…

➢ *The missing piece of the puzzle!*

GPM for Landslide Prediction

- Our proposed framework consists of three components:
  1. Estimation of the hydrologic state constrained to observation
  2. Prediction of landslide occurrence through near real-time slope stability assessment
  3. Landslide routing to provide high resolution maps of hazard

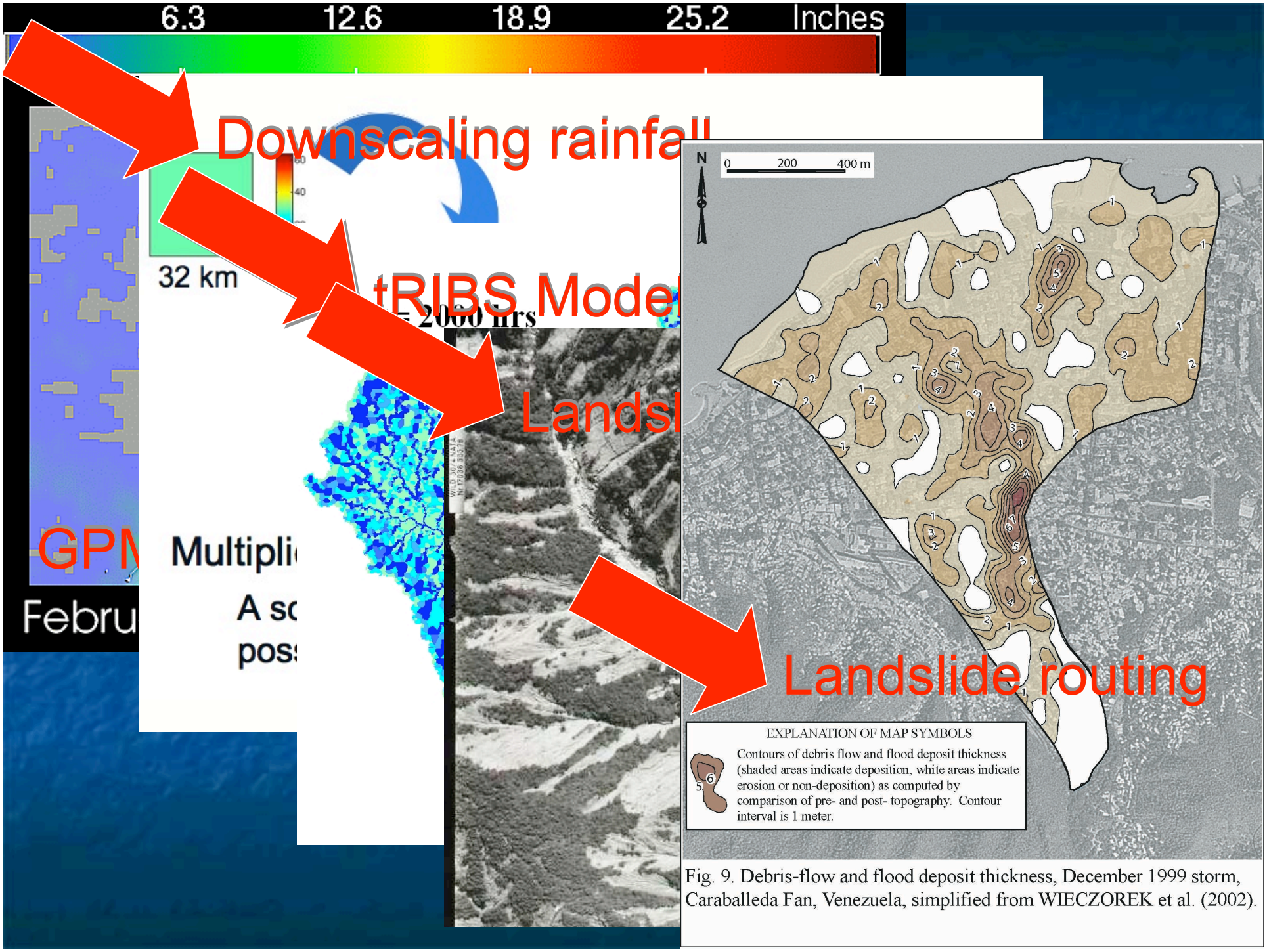
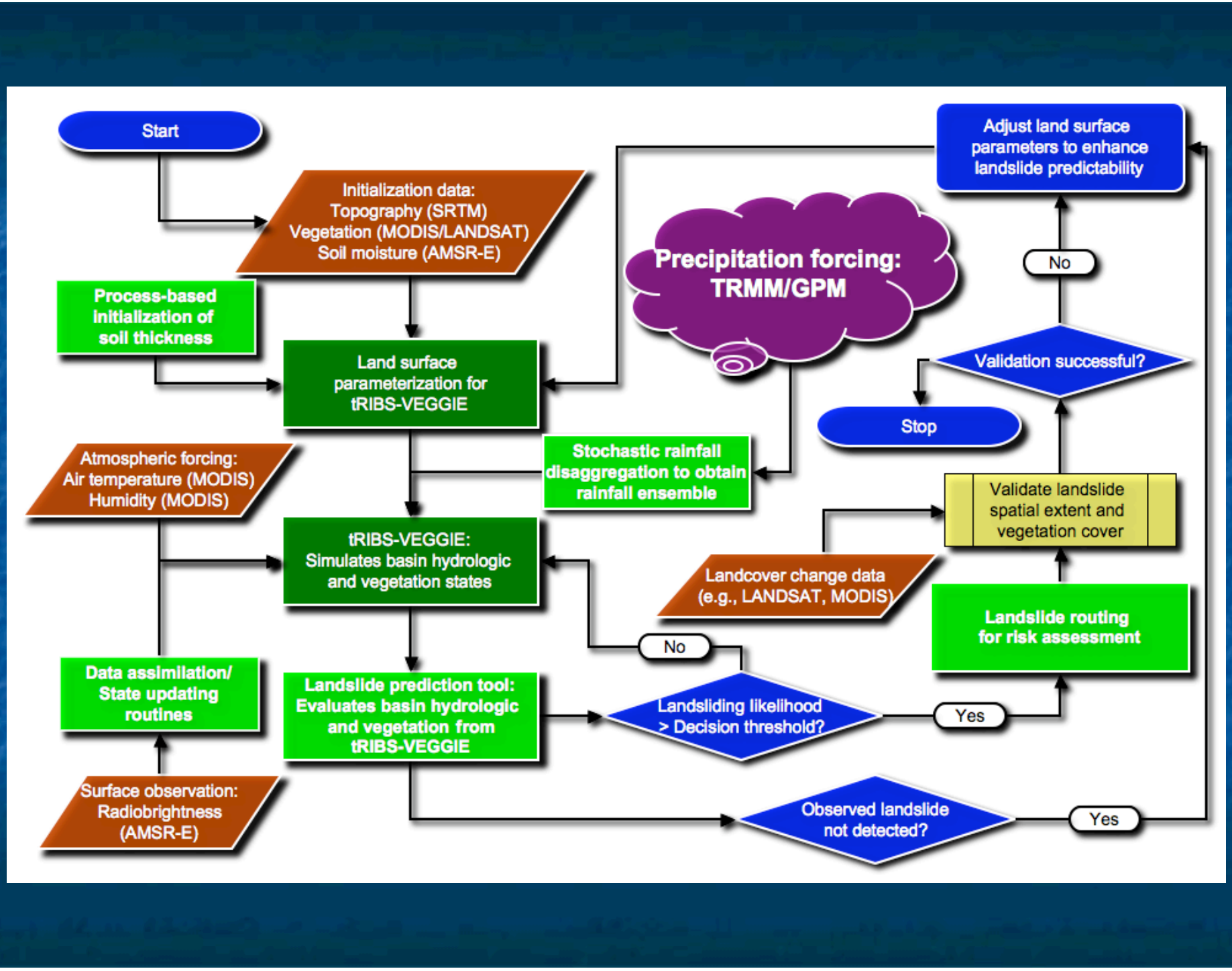


Fig. 9. Debris-flow and flood deposit thickness, December 1999 storm, Caraballeda Fan, Venezuela, simplified from WIECZOREK et al. (2002).


Start
Initialization data:
Topography (SRTM)
Vegetation (MODIS/LANDSAT)
Soil moisture (AMSR-E)
Process-based initialization of soil thickness
Land surface parameterization for tRIBS-VEGGIE
Precipitation forcing: TRMM/GPM
Adjust land surface parameters to enhance landslide predictability
No
Validation successful?
Stop
Stochastic rainfall disaggregation to obtain rainfall ensemble
Atmospheric forcing:
Air temperature (MODIS)
Humidity (MODIS)
tRIBS-VEGGIE:
Simulates basin hydrologic and vegetation states
Validate landslide spatial extent and vegetation cover
Landcover change data (e.g., LANDSAT, MODIS)
Landslide routing for risk assessment
No
Data assimilation/ State updating routines
Landslide prediction tool:
Evaluates basin hydrologic and vegetation from tRIBS-VEGGIE
Landsliding likelihood > Decision threshold?
Yes
Surface observation:
Radiobrightness (AMSR-E)
Observed landslide not detected?
Yes

Conclusions

- Landslides are often the result of weather
- Prediction of landslides globally with sufficient spatial and time resolution requires remote sensing data
- Lynchpin of advancing landslide prediction is rainfall
- Together with other NASA products GPM serves to significantly advance landslide prediction globally